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The effect of information provision on supermarket consumers' use of and preferences for carbon labels in Germany

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ABSTRACT

To limit climate change, significant reductions in greenhouse gas emissions are needed. Changes to consumer behavior could be one strategy to reach emission reduction targets. In this context, the role of information is crucial. One way of informing consumers about the climate impact of their food choices is through labels on the packaging. Providing additional information about labels or climate friendly food behavior directly before the product choice is made can stimulate the use of and preferences for carbon labels. The main aim of this study was to analyze the effect of information provision on supermarket consumers in Germany and their use of and preferences for carbon labels. It was also studied which types of carbon labels consumers prefer and how important these labels are as a criterion for the product choice. Data from a focus group workshop and two in-store surveys, including a pair wise comparison experiment and two Discrete-Choice Experiments, were used. The results show that providing additional information about labels can enhance the use of these labels and increase consumers' focus on the labels when making their product choice. It can also influence the general decision to buy or not buy a product and the preferences for the existence of a label. Consumers prefer carbon labels which use a scale and a traffic light color system. However, carbon labels are generally not important in consumers' decision-making process.

1. Introduction and background

To limit climate change, significant and constant reductions in greenhouse gas (GHG) emissions are needed (ipcc, 2014). European Union (EU) households were responsible for almost one fifth of the GHG emissions in the EU-27 in 2012 (European Union, 2015), meaning that changes in consumer behavior could be a strategy to reach emission reduction targets. Behavioral changes relating to food, mobility and housing seem particularly promising, since these areas have large climate impacts (Faber et al., 2012). With respect to food, different studies have identified potentially beneficial shifts in food consumption, such as changing to a vegetarian diet, reducing consumption of meat and dairy products, eating healthily or eating seasonal vegews etc. (Faber et al., 2012; Garnett, 2011).

In addition to consumer education, information provision is one possibility to empower consumers to make informed choices about their consumption (Thøgersen, 2005). Thus, information is crucial in determining consumer behavior changes related to global warming issues (Lombardi et al., 2017). One way of informing consumers about the climate impact of their food is through carbon labels on food packaging. Labels provide several advantages, such as increasing transparency, reducing negative external effects and illustrating the negative effects of consumption behavior (Eberle et al., 2011). Many national and international carbon labelling programs already exist (Engel et al., 2012), several of which relate to agriculture or food production. There are five different types of labels, including low carbon labels, carbon intensity labels, carbon rating labels, carbon reduction labels, and carbon neutral labels (Walter and Schmidt, 2008).

The ability of these labels to considerably diminish GHG emissions will be determined by consumer responses to the labelling (Elofsson et al., 2016). Several studies have found positive consumer preferences towards sustainability labels (Grunert et al., 2014; Van Loo et al., 2014) and specifically towards carbon labels

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(Onozaka and Mcfadden, 2011; Thøgersen and Nielsen, 2016; Van Loo et al., 2014). However, according to the pan-European study by Grunert et al. (2014), use of sustainability labels is low. In that study, it was concluded that the future use of sustainability labels will depend on the extent to which it is possible to turn consumers' concern about sustainability into actual behavior.

Labels can be used by consumers as a shopping aid, if they are familiar with them. However, if the labels are not familiar or not fully understood, providing additional information to consumers can affect their intention to purchase or the way in which product attributes are perceived (Hoogland et al., 2007). Provision of information about labels or climate friendly food behavior directly before the actual food purchase may be one way of (further) stimulating the use of, and preferences for carbon labels. The aim of this study was to analyze the effect of information provision on supermarket consumers' use of carbon labels as well as their preferences for these labels in German. Additionally, it was also studied which types of carbon labels the consumers preferred and how important these labels were in terms of product choice. These topics are interesting for several reasons. First, studies have documented a knowledge gap concerning the relevant concepts and terminology. Hartikainen et al. (2014) found a low understanding of the concept of "product carbon footprint (PCF)" and Upham et al. (2011) showed that consumers would need substantially more information about carbon labelling to be able to make sense of it. Second, carbon labels will have to strongly compete for shoppers' attention (Upham et al., 2011) and additional information could help labels to gain this attention. Third, studies have confirmed that comprehensible communication and information measures can positively alter preferences for sustainability attributes in general (Risius and Hamm, 2017) and specifically for climate neutral products (Lombardi et al., 2017). Elofsson et al. (2016) showed that an information sign at the point of sale (POS) increased demand for climate-certified milk. This study suggests that further information could be provided by retailers directly at the POS.

In the analysis, a stepwise, mixed method approach was used. First, in a focus group (FG) workshop, three carbon labels which were preferred from the consumers' point of view were identified. Subsequently, the effect of information provision on the use of these carbon labels was tested in decisions relating to a climate friendly product using a pairwise comparison experiment, which was conducted within an initial quantitative in-shop survey. The results provided insight into whether the provision of information on carbon labels directly before the decision is made to buy a product helped to better identify climate friendly products. Based on the results, two carbon labels were selected, which were further examined in a second in-shop study. In this, the effect of information provision on the preferences for carbon labels was tested using Discrete-Choice-Experiments (DCE). The stepwise approach was necessary to avoid overwhelming the respondents in one survey and to increase the reliability of the results.

In both studies, it was concentrated on fruit and vegetables since Cho (2015) recommends analyzing the influence of sustainability labeling on consumer choices using products that consumers routinely purchase. Germany is of particular interest because it is one of the countries with the highest CO2-emissions per capita in Europe (iea 2014).

The remainder of the manuscript is structured as follows: The next section introduces the methods used to collect and analyze the data. This is followed by a description of the results of the two experiments in chapter 3. The manuscript ends with a discussion of the results (chapter 4) and the major conclusions (chapter 5).

2. Material and methods

2.1. Data

The analysis is based on a FG workshop held in May 2013 (n = 12) and two quantitative consumer studies conducted in September 2013 (n = 379; survey 1) and February 2014 (n = 413; survey 2). Other studies dealing with the sustainability attributes of food also used a mixed method approach (e.g. Zander et al., 2013; Lombardi et al., 2017).

The participants of the workshop were individuals who are responsible for grocery shopping. The target group of both quantitative surveys was individuals aged 16 + who are grocery shoppers for their household and who buy apples or tomatoes at least occasionally. Thus, all participants had experience in decision making with respect to the analyzed products. Data was collected by means of computer assisted personal interviews, which took place in four different EDEKA grocery stores located in southern Germany. The in-shop surveys helped to build a natural shopping situation. In survey 1 (S1), a pairwise comparison experiment was conducted to analyze the use of different carbon labels. In survey 2 (S2), two DCEs were undertaken. In each survey, half of the sample, which was randomly selected, was treated with additional information to test the effect of information provision. A similar procedure was used by Øvrum et al. (2012). In S1, the information group received information about the tested labels (see Fig. A1), i.e. what the label represents, if it is mandatory, who supports the label or if there is an external check etc. In S2, recommendations on climate friendly fruit and vegetable choices were given (Fig. A2) and a calendar was provided with information on the seasonality of different production methods (e.g. heated greenhouse, field-growing, stock articles) in Germany (Fig. A3).

2.2. Tested label formats and design of experiments

2.2.1. Tested label formats

Three different carbon labels were tested in this study (Fig. 1). They were chosen on the basis of the FG workshop, which lasted 2 h. The discussion followed a semi-structured interview guideline, which had a question sequence suggested by Benighaus and Benighaus (2012). Under the guidance of an experienced moderator, the 12 participants initially discussed the general suitability of carbon labels as an information instrument and the requirements of carbon labels using Metaplan technique. Afterwards, they were presented with 9 carbon labels (Fig. A4), which had been identified or developed based on the literature and market research on existing and possible carbon labels. Subsequently, the joint group attempted to rank the labels according to their preferences (Klein et al., 2015). The participants preferred three types of labels, including those which allowed a classification/comparisons of the climate impact of different products (e.g. A4, A8,A9), labels which are a differentiation of an existing label (e.g. A1) and simple one-tick labels (e.g. label A5). Thus, three labels were included in the pairwise comparison test: 1) The hypothetical scale label was

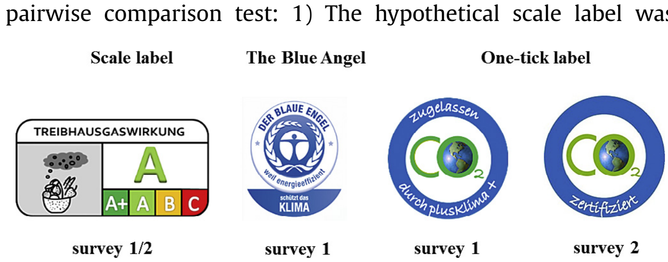

Fig. 1. Tested label formats. Source of foto: http://www.blauer-engel.de/_medien/der_blaue_engel/ logos_cluster.jpg.

included since it categorizes a product into different climate effect groups, which can be either positive or negative. The label used the scale format known from the EU-energy label (A+, A, B, C). The design of the label was inspired by the French VOC label, which classifies e.g. construction products according to their emissions (Vergez, 2012). It also uses traffic light system to communicate the products' relative performance. This combination (traffic light color ranking) has been shown to be especially successful in shifting consumers' choices towards relatively low-carbon products (Thøgersen and Nielsen, 2016). 2) The Blue Angel (protection goal: protects climate) was included as it is already widely known in Germany.[1] 3) A hypothetical one-tick label was also used. It represented the approval of a fictitious CO2-reduction approval organization. It was claimed that this label was allocated to a product if it causes significantly less CO2 during its whole life cycle than a comparable product.

Based on the results of the first survey, only the scale label and a modified version of the one-tick label were included in the DCE in S2.

2.2.2. Pairwise comparisons test

To test the use of different carbon labels in the decision process for a climate friendly product alternative, a pairwise comparison test was conducted in S1. The experiment was partly adopted from a study by Borgmeier and Westenhoefer (2009). Nine pictures of real food pairs were randomly shown to participants, who had to indicate which alternative was more climate friendly. In the experiment, photos of existing packaged apples/tomatoes (Fig. A5) from different supermarkets were used. The goods had different information on the packaging (e.g. brand, origin) and were packed in different materials. Thus, the use of carbon labels in a situation that mimicked a food choice made by consumers in a supermarket could be tested. However, it was not possible to know exactly which information was used by the interviewees to make their decision. Therefore, after the test respondents were asked to tell which decision criteria they used. The specified answers related to the information on the packaging and included the price, country/region-of-origin, organic production, climate label, quality label, brand, and others.

The climate friendliness of the products was determined by the respective label. In the case of scale label, the scale indicated which product was more climate friendly (e.g. A+ was more climate friendly than C). In the case of The Blue Angel, the protection goal or the presence of the label was the respective indicator. For example, if there was a product labelled "protects water" and a second was labelled "protects climate", the latter was assumed to be the more climate friendly one. In the case of one-tick label, the existence of the label indicated the more climate friendly product. Three pairwise comparisons had to be answered for each label. The pairs were selected on the basis of a face-to-face pre-study ($n = 53$), where respondents had to make 5 pairwise comparisons per label following the same procedure as in the main survey. Based on these results, it could be determined which pairwise comparisons discriminated lowest between the participants. For each label, the pairs with the highest share of correct answers were excluded from the main survey as they were too easy to answer. The share of correct answers was higher than 90% for all excluded pairs.

After the experiment, respondents were asked to evaluate the tested labels. Here, the respondents had to choose their favorite label in terms of comprehensibility, credibility, provision of information, and helpfulness with respect to their choice.

[1] Actually, The Blue Angel is not used for food, but only 40% of German respondents knew this fact in the study by Stieß and Birzle-Harder (2013).

2.2.3. Discrete-choice-experiment

In S2, two DCE were conducted to analyze preferences for carbon labels. DCEs mimic a realistic buying situation in which consumers choose between different product alternatives (Sammer and Wüstenhagen, 2006), e.g. different tomatoes or apples, with varying product attributes from a restricted product set. Based on the choices of the respondents, the importance of product attributes (e.g. carbon label) and the utilities of different attribute levels (e.g. different scales of carbon labels) can be determined.

DCE are based on random utility theory (RUT), which assumes that an individual q maximizes his utility, which is "the level of happiness that an alternative yields to an individual" (Hensher et al., 2007, p. 707), when choosing between J alternatives. The utility U_{iq} of the ith alternative for the qth individual is composed of a systematic component V_{iq}, and a random, unobserved component ε_{iq} such that (Louviere et al., 2000, Hensher et al., 2007):

$$\mathrm{U_{iq}} = \mathrm{V_{iq}} + \varepsilon_{\mathrm{iq}} \tag{1}$$

By using Hierarchical Bayes (HB) estimation, individual-level utilities can be estimated (Sawtooth Software, 2016) and the heterogeneity of the respondents can be captured.

In the experiments, respondents had to choose eight times between three different tomatoes and a NONE-option and 6 times between three different apples and a NONE-option (see Fig. A6 for an example of the choice set). Additionally, one Holdout-Task for every product was included. Both products were characterized by the attributes origin, production, label, and price. Origin and production were included because origin is an important sustainability criteria for apples and tomatoes (Onozaka and Mcfadden, 2011) and both can have an important influence on the carbon footprint of this type of produce (Müller-Lindenlauf, 2012). The inclusion of the label was important for answering the research questions and price was necessary to create a realistic purchase situation. Additionally a NONE-option was included, which allowed the participants to reject all of the offered apple or tomato types.

In the case of tomatoes, origin was defined by six levels (Table 1), two of which were designations of origin (local produce and imported produce), while four also indicated the production method (e.g. plastic tunnel, greenhouse heated with fossil fuel, greenhouse heated with renewable energy). This is plausible as the study of Müller-Lindenlauf (2012) showed that the combination of origin and production method can have a strong impact on the carbon footprint of tomatoes. Production comprised the levels conventional, organic (EU-Label) and Bioland, which is the biggest organic farming association in Germany (BÖLW, 2015). For the tomatoes, the scale label was tested, which had five levels (no-label, A +, A, B, C). Price was included conditionally to the production method and was measured with four levels. The levels were defined based on a check of prices in stores and advice from the sales management of the supermarkets where the survey was conducted. To avoid overwhelming the survey participants, the apple experiment was made less complex. Only three different origins were tested, including Baden-Württemberg (BW) (local alternative), South Tyrol (EU-import alternative) and New Zealand (overseas import). The production levels included conventional and organic (EU label) production. The one-tick label was tested either by being present or not. Again, price was related to the production method and measured with three levels, which were selected in the same way as described for the tomatoes.

Based on the specified attributes and levels, a controlled random design (20 questionnaire versions) was generated using the random task generation method "Balanced Overlap" with the software SSI web 8.3.2. A random design was used since it reduces potential bias from learning and order effects. Additionally, all

Table 1
Attributes and levels used in the DCE.

Attribute	Tomatoes	Apples
Origin and production method	BW, Spain, BW (fossil fuel), BW (renewable energy), BW (high plastic tunnel), Spain (high plastic tunnel)	BW, South Tyrol, New Zealand
Production	Conventional, organic (EU-Label), Bioland	Conventional, organic (EU-Label)
Label	No label, A+, A, B, C	One-tick label, no label
Price	Conventional: € 1.14, € 1.35, € 1.49, € 1.70 Organic: € 2.82, € 3.34, € 3.70, € 4.22	Conventional: € 2.49, € 2.74, € 2.99 Organic: € 2.99, € 3.36, € 3.72
None		

[a]BW: Baden-Württemberg.

interactions can be measured, whether or not they are anticipated as important at the time the study is designed (Sawtooth Software, 2014).

For the tomatoes, a prohibition was set on the combination of BW, produced in greenhouse gas heated by fossil fuel and label A+, meaning that this combination did not occur in the experiment. For the tomato experiment, respondents were asked to imagine that it was summer and they wanted to buy tomatoes. In the apple experiment, respondents were asked to imagine that the apples were bought on the day of the survey (in February). This procedure was used to test whether respondents considered the information provided about the season and production method in their choice or not.

Based on the collected DCE-data, individual part-worths were estimated using the HB model in SSI Web 8.3.2. These part worths are "the proportion of utility that can be attributed to a specific attribute" (Hensher et al., 2007, p. 703). The HB model is considered hierarchical as it has two levels. On the higher level, it is assumed that individual part-worth utilities are described by a multivariate normal distribution. On the lower level, it is assumed that given an individual's part-worth utility, the probabilities of participants choosing specific alternatives, are governed by a multinomial logit model (for a detailed description see Sawtooth Software, 2016). The parameters of the model are estimated using an iterative approach based on Gibbs sampling and the Metropolis Hastings Algorithm (Sawtooth Software, 2016). 20,000 iterations were completed in this study, of which the first 10,000 were not used for the results. This was done to avoid the influence of starting values.

In this study, the variable describing the membership in the treatment group was included as covariate in the estimation, i. e. it was included as an additional independent variable. In HB models with upper-level covariates, it is supposed that individuals' part-worth utilities are related to the covariates through a multivariate regression model (Orme and Howell, 2009).

3. Results

3.1. Socio-demographic characteristics of the samples

Table 2 shows the socio-demographic (SOD) characteristics of the two samples (total), the information group, the no-information group and the relevant universe (householder). In both studies, approximately two thirds of the respondents were female, which would be expected as women are still primarily the purchasers of food for German households (Verbrauchernalyse, 2012). The share of young people (<30 years) and bigger households (3 + persons) was higher than in the universe in both cases. Also, an over-representation of people with a higher education degree was found. No statistically significant differences in the distribution of the described SOD characteristic of S1 and S2 were observed. Comparing the information and no-information group from S1, the former comprised more men, was slightly older and had a lower share of highly educated people. In S2, there were more men, more middle-aged (30–49 years) participants and more 2-person households in the information group than in the no-information group.

3.2. Pairwise comparison experiment and evaluation of the labels

The results of the pairwise comparison experiment are shown in Table 3. All labels helped consumers to identify climate friendly alternatives, with the number of correct answers (minimum total: 2.4) being high for all tested formats. The one-tick label gave the most support to consumers, while the scale label provided the least support in choosing the climate friendly alternative. Information about the labels, which was given to the respondents before the experiment, helped consumers to better identify the climate friendly product in the case of the one-tick and The Blue Angel labels but not in the case of the scale label.

After the experiment, respondents were asked about which criteria they had used to make their decision in a pairwise comparision test. Overall, most of the respondents stated that they used the carbon label (74%; Table 4). However, some of the respondents also used information about the origin of the product (65%) or, to a lesser extent, the quality or organic label. In the information group, use of the carbon label as a decision criterion was significantly higher than in the no-information group, while the opposite was found in the case of "other information" (e.g. weight, packaging material). Use of information about the origin was on the same level in both groups. It was also checked how many decision criteria participants used: 22% of the respondents used only one criterion, 42% two criteria and the remainder three or more. If respondents used only one criterion, this was the carbon label in the majority of the cases (67%). Participants in the information group used the carbon label significantly more as the exclusive decision criterion (75%) than the no-information group (59%) (Emberger-Klein et al., 2015). No statistically significant differences in the total number of criteria used in both groups found were found.

In summary, the majority of the consumers used the carbon label when instructed to identify a climate friendly alternative. Providing additional information on the labels directly before the decision enhanced the stated use of the label as well as the focus on the labels.

Table 5 shows the evaluation of the tested labels in different categories. Consumers considered the scale label to be the most comprehensible, as providing the most information, and as being most helpful in choosing a climate friendly food alternative. The Blue Angel was considered to be the most credible. No clear differences in the evaluation of the labels between both treatment groups were found. Only in the category "helps best …", the information group considered the scale-label to be better and the no-information group considered the one-tick label to be worse. Following this evaluation, the scale label and the one-tick label were included in the DCE of S2, since this helped consumers best to

Table 2
Description of the sample of survey 1 and 2.

		Survey 1 (09/2013)			Survey 2 (02/2014)			House-holder[b]
		No information	In-formation	Total	No in-formation	In-formation	Total	
		187	192	379	208	205	413	
Gender (%)	female	66.8	71.4	69.1	64.9	73.2	69.0	67.3
	male	33.2	28.6	30.9	35.1	26.8	31.0	32.7
Age (%)	16-29 years	26.2	21.4	23.7	25.5	23.9	24.7	11.2
	30-49 years	34.2	35.9	35.1	25.0	37.6	31.2	34.5
	50 + years	39.6	42.7	41.2	49.5	38.5	44.1	54.3
Size of house-hold (%)	1 person	17.7	18.8	18.2	15.4	11.2	13.3	26.3
	2 persons	42.3	37.0	39.6	32.7	46.3	39.5	38.1
	3 + persons	40.1	44.3	42.2	51.9	42.4	47.2	35.6
Education[a] (%)	low	1.1	4.7	2.9	3.8	2.9	3.4	11.9
	medium	64.2	65.6	64.9	65.9	65.9	65.9	70.8
	high	34.8	29.7	32.2	30.3	31.2	30.8	17.3

[a] Low: no/does not yet have a school diploma, Certificate of Secondary Education (CES) without apprenticeship, Medium: CES with apprenticeship, secondary school, higher education entrance qualification High: higher education.
[b] Individuals 16 + years from Baden-Württemberg who are mainly or occasionally responsible for the household shopping and who had bought food from EDEKA during the past months (Source: Verbrauchernalyse, 2012).

Table 3
Results of the pairwise comparisons.

		Scale label[d]	The Blue Angel[d]	One-tick label[d]
No. of correct answers (total)	mean (std.)	2.4 (0.73)	2.5 (0.68)	2.7 (0.62)
No. of correct ansers (information)	mean (std.)	2.5 (0.65)[a]	2.7 (0.56)[b]	2.8 (0.53) [c]
No. of correct answers (no information)	mean (std.)	2.3 (0.79)[a]	2.4 (0.77) [b]	2.6 (0.69) [c]

Results of Kruskal-Wallis equality-of-opulations rank tests.
[a] No significant differences in no. of correct answrs between information and no information group in case of tested scale label.
[b] Significant differences ($p < 0.001$) in no. of correct answers between information and no information group in the case of The Blue Angel.
[c] 'significant differences ($p < 0.001$) in no. of correct answers between information and no information group in the case of the One-tick label.
[d] Total number of choices: 3; No = number, std. = standard deviation.
Source: (Emberger-Klein et al., 2015)

Table 4
Decision criterion in the pair wise comparison experiment by treatment.

	No-information group mean (std.)	Information group mean (std.)	Total mean (std.)
N	187	192	379
Price was used (=1, 0 otherwise)	0.07 (0.26)	0.04 (0.20)	0.06 (0.23)
Country/Region-of-origin was used (=1, 0 otherwise)	0.67 (0.47)	0.63 (0.49)	0.65 (0.48)
Organic production was used (=1, 0 otherwise)	0.28 (0.45)	0.24 (0.4 3)	0.26 (0.44)
Carbon-label was used (=1, 0 otherwise)	0.68 (0.47)**	0.81 (0. 40)**	0.74 (0.44)
Quality-label was used (=1, 0 otherwise)	0.37 (0.48)	0.33 (0.47)	0.35 (0.48)
Brand was used (=1, 0 otherwise)	0.09 (0.28)	0.08 (0.28 8)	0.08 (0.28)
Other information was used (=1, 0 otherwise)	0.12 (0.33)*	0.06 (0.23)*	0.09 (0.29)

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (Independent group *t*-test (Satterthwaite's method).

Table 5
Evaluation of the tested labels.

	Scale label	The Blue Angel	One-tick label
Most comprehensible %	62.3	26.1	11.6
Most credible %	40.9	49.3	9.8
Provides the most information %	81.0	11.1	7.9
Helps best to choose a climate friendly alternative %	68.3	19.8	11.9

Source: (Emberger-Klein et al., 2015)

identify climate friendly alternatives.

3.3. Preferences for carbon labels

Table 6 provides the results of the HB estimation of the DCE-data. In the case of apples, all variables were defined discretely and integrated as effect coded variables. The same is true for tomatoes, except for the price variable. It was linearly defined using proportional price ranges, since in this model, a relatively high number of parameters had to be estimated and a linear coded price variable saves estimates of parameters. Additionally, interaction effects between price and production method were included in both models because price levels were made conditional on the production method. Table 6 shows two sets of part-worths for every product, as the variable describing the membership in the treatment groups was included as covariate. The first set represents the mean population estimates of part-worths of the last 10,000 draws for the information group and the second for the no-information group.

Following Orme and Howell (2009), it was checked if the covariate weights were significantly different from zero at or better than the 90% confidence level (2-sided test) by inspecting if the percent of draws that were positive were >95% or < 5%.

Convergence of the HB estimation was checked using the RLH

Table 6
Part-worths and average importance of the different attributes of the DCE.

Tomatoes				Apples			
		Information (n = 205)	No information			Information (n = 205)	No information (n = 208)
Origin	BW	**2.323**	2.587	Origin	BW	**4.629**	4.868
	Spain	**−2.502**	−2.917		South Tyrol	0.340	0.345
	BW fossil fuel	0.217	0.485		New Zealand	**−4.969**	−5.213
	BW renewable energy	**0.623**	0.953	Production	Conventional	**0.319**	0.323
	BW high plastic tunnel	**1.756**	**1.188**		Organic (EU label)	**−0.319**	−0.323
	Spain high plastic tunnel	**−2.417**	−2.295	Label	One-tick label	**0.916**	0.845
Production	Conventional	0.375	0.347		No label	**−0.916**	−0.845
	Organic (EU-Label)	−0.220	−0.396	Price	Low	**1.141**	0.828
	Bioland	−0.154	0.048		Medium	−0.103	−0.136
Label	No label	**−0.899**	**−0.363**		High	**−1.038**	−0.692
	A + Label	**0.732**	0.737	Interaction	ConventionalXlow	**−0.704**	−0.546
	A Label	**0.880**	0.473		ConventionalXmedium	**0.424**	0.377
	B Label	0.008	−0.104		ConventionalXhigh	**0.280**	0.169
	C Label	**−0.721**	−0.743		OrganicXlow	**0.704**	0.546
Price	Price	**−5.371**	−4.383		OrganicXmedium	**−0.424**	−0.377
Interaction	ConventionalXprice	**5.225**	6.122		OrganicXhigh	**−0.280**	−0.169
	Organic (EU)Xprice	**−2.156**	**−0.718**	None	NONE	**−2.634**	**−4.252**
	BiolandXprice	**−3.069**	**−5.403**				
NONE	NONE	**−2.617**	**−3.910**				
Average importance mean (std. dev) mean (std. dev)	Origin	40.1% (14.5%)	42.5% (15.7%)	Average importance	Origin	58. 9% (19.8%)	61.3% (19.0%)
	Production method	27.1% (15.6%)	28.4% (17.2%)		Production	13.1% (10.0%)	13.9% (10.2%)
	Carbo label	18.0% (7.3%)**	15.8% (8.1%)**		Carbon label	12.6% (10. 2%)	12.4% (9.3%)
	Price	14.8% (9.3%)	13.4% (8.4%)		Price	**15.4% (10.3%)****	**12. 4%** (9. 5%)

Part-worths: sig. parameters (90% confidence level, 2-sided test) are marked **bold, underlined**; average importance: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$ (Two sample *t*-test).

(root likelihood) value, which is the geometric mean of the predicted probabilities. In this study, respondents had to choose between $k = 4$ alternatives. If there was no information about part-worths, it would be predicted that each alternative would be chosen with a probability of 25% (1/k). Consequently the RLH would also be 25%. However, average RLH values of the models were 0.721 (tomatoes) and 0.761 (apples), indicating that the estimation was almost/more than three times better than chance (Sawtooth Software, 2016). To check the predictive validity, hit rates for both Holdout-Tasks were analyzed, which were computed from individual part-worths using the first-choice rule. The hit rates were 65.9% (tomatoes) and 58.8% (apples), which is higher than the random hit rate (25%). Thus, both models could predict the choice of tomatoes or apples.

The determined average relative importance shows that origin was the most important decision criterion for both products and every treatment group. The importance of origin was higher for apples. For tomatoes, the production method was also important, followed by the carbon label and price. These three attributes were almost equally important in the apple decision model. This indicates that the carbon labels were of minor importance in the decision-making process with respect to both the analyzed products. Statistically significant differences between the information and no-information group only existed for the label, which was significantly more important for the information group compared to the no-information group in the case of the tomato-decision, and for price, which was more important for the information group than for the no-information group (apples).

In both models, preferences for a label were found, since a higher utility can be observed for the presence of the one-tick label compared to the absence of a label (apples). In the tomatoes model, the lowest utility can be found for the option 'No label' in the information group. In the no-information group, the C-level has a lower utility than the "no label" level. Additionally, utility decreases from A+ to C, indicating that the respondents understood the scale.

Higher utility was observed for local produce (BW) than for imported produce in both models. In the case of tomatoes, additional information on the production method (e.g. renewable energy) did not lead to advantages for local produce, as the utilities for these levels were lower than for the origin information. However, in the case of the Spanish tomatoes, the opposite was observed. In that case, utility was higher when additional information on the production method was given compared to the pure origin-indication.

As expected, utility decreased when price increased in both models. Given the average prices for each production method, higher utilities were found for conventional compared to organic tomatoes (EU or Bioland) or apples. However, the interaction effects in the apples model showed that the medium price level was preferred for conventional apples compared to either the high or low price levels. In contrast, lower price levels were preferred for organic apples compared to medium and high price levels. For conventional tomatoes, utility increased as price increased, while the opposite was observed for the organic produce.

In both cases, a negative utility was found for the NONE-option, in which the consumer does not select one of the specified apple or tomato alternatives. There was a statistical difference between this option between the information and no-information groups. Both models show that when no information was provided, the part-worth utility for the NONE-option decreased. This suggests that respondents used the given information on growing season (e.g. German apples are normally stock articles in February) and decided not to buy in an 'unfriendly' climate situation (here: stock articles must be refrigerated all winter).

In the tomatoes model, further significant differences were found between both treatment groups, which are obvious for the "No label" level, for local tomatoes produced in high plastic tunnels, and the interactions between organic products (EU, Bioland) and price. For example, people who did not receive further information on the growing seasons/tips for climate friendly food choices had a lower utility for local tomatoes produced in high plastic tunnels and a higher utility for the "No label" level.

In summary, a carbon label is only of minor importance in the decision process. However, its presence, irrespective of the format, is preferred to its absence. Additional climate relevant information can influence the general decision to buy or not to buy a product, the preferences for the existence of a label and for climate-relevant product attributes (e. g. production in plastic tunnel).

4. Discussion

As stated in the introduction and shown by the results, the role of information can be crucial to encouraging more climate friendly consumer behavior. In this study, it was found that the majority of consumers (74%) used carbon labels on the packaging when being instructed to identify a climate friendly food alternative. The provision of additional information on these labels enhanced the use of them and the ability to identify climate friendly products. Similar results were found in other studies. In the survey by Samant et al. (2016), participants were exposed to information on sustainability labels and then subsequently rated the importance of labels when purchasing chicken significantly higher than in the pre-education situation. Additionally, Elofsson et al. (2016) showed in a field experiment that an in-store information sign placed close to climate-certified products has the potential to increase short-term demand for these products. Therefore, it could be recommended to ensure that carbon labels are accompanied by related information, which is provided directly before the actual product choice takes place, e.g. by retailers at the POS. Such information can help consumer to improve their knowledge of labels and make them more confident in their own knowledge (Samant et al., 2016). It can also help to alter consumers' beliefs about a product and to choose products which are more in line with their personal values (Hoogland et al., 2007).

We also found that two-thirds of participants also used the information on origin of the product to select the more climate friendly product. This indicates that a high proportion of consumers evaluated climate friendliness of the products based on the place of production. This relates to the debate on food miles, in which it is argued that the further a product travels from the production site to the market, the greater the environmental damage and contribution to global warming (Avetisyan et al., 2014). However, Avetisyan et al. (2014) argued that this issue is more complex, since for many products very high GHG emissions arise from the on-farm production of the products. It was also observed that consumers in the information group used the carbon label significantly more often as the exclusive decision criterion. This indicates that by giving further information on labels, it is also possible to prevent consumers from using ambiguous evaluation criteria.

In the FG workshop, it was found that the scale label was one of the preferred carbon labels of nine alternatives. Additionally, the evaluation of the different labels in S1 showed that the scale label was evaluated more positively by consumers than the other two formats with respect to comprehensibility, provision of information and helpfulness for choice. This positive evaluation is in line with other studies (Hartikainen et al., 2014; Sharp and Wheeler, 2013). The label provided a traffic light system in addition to the scale. Thøgersen and Nielsen (2016) showed that carbon labels using such a design can significantly amplify the effect of carbon labeling on consumer choices, since they can shift it away from relatively carbon-intensive products towards relatively low-carbon ones. The authors claim that the traffic light color classification allows consumers to use simple heuristics (choose green, avoid red) to identify preferable products. The authors assumption that such labels, which indicate the relative performance of a product and indicate the negative case, can be informative, helpful and comprehensible, are supported by the results of this study.

In the DCE, clear consumer preferences for the presence of carbon labels were observed. Both tested labels increased the consumers' utility compared to the situation without a label. This is consistent with the results of previous studies (Grunert et al., 2014; Van Loo et al., 2014). It can also be concluded from the DCE that carbon labels are not important for consumers' decision-making processes with respect to fresh produce. However, additional climate relevant information could enhance the relative importance of the label in the decision process as well as the preference for it. It could also stimulate consumers' preferences for specific product characteristics linked to CO2-emissions. It was also found that such information influenced the general theoretical decision to buy or not to buy a product and thus could avoid food choices, which are unfavorable regarding CO2-emissions.

The results suggest that carbon labelling could be a suitable consumer information instrument to mitigate CO2-emissions related to food consumption. Thus, a carbon label e.g. from the government which helps to induce a broader discussion on food derived GHG emissions among consumers, could be worthwhile. Labelling schemes can also help to change public opinion and awareness and help individuals to make sense of highly complex issues (Hartlieb and Jones, 2009). This is especially important as climate protection is a multifaceted issue with high political priority and it should also address consumer behavior more.

The results provide some indications that provision of additional information about carbon labels (e.g. their meaning or external checking mechanisms) and climate friendly food behavior (e.g. favorable product choices) directly before the actual purchase choice can stimulate (more) climate friendly behavior. Information on the abovementioned aspects could e.g. be provided by (food) retailers directly at the POS. As they are located between consumers and producers in the value chain, they have the potential to inform their customers about the consequences of their choices and help to reduce GHG emissions associated with food consumption (Ekelund et al., 2014). The results of this study suggest that retailers would be in a good position to induce climate friendly food choices through information provision. In Germany, with its highly concentrated food retail sector (CR5 2011: 71,7% (Haucap et al., 2013);), this option could be particularly promising as the engagement of a small number of retailers could reach a substantial number of consumers. However, retailers are virtually completely inactive in this field at present (Ekelund et al., 2014) and it is questionable as to whether they would be interested in engaging in this field. Reasons for this are diverse. Possible explanations are that retailers do not want to damage the meat segment, which is one of the most promising segments for reducing GHG emissions, or retailers do not want to encourage consumers to eat less food. Retailers may also not know how to communicate climate mitigating behavior effectively or profitably as normative guidelines are lacking (Ekelund et al., 2014). Communication research could help to develop effective strategies. Research could also support retailers by providing a reliable and accessible knowledge base on climate friendly food products and consumer behavior. This would include lifecycle assessments of various food products (alternatives), production systems (e.g. organic, local) or consumer behavior (e.g. storage, cooking).

There are several limitations to this study, which indicate the need for further research. Firstly, the surveys were only conducted in the supermarkets of one German retailer. Further studies in other

retail channels (e.g. discounters) would provide a broader picture. Further, the results are based on hypothetical choices, which are prone to hypothetical bias (e.g. Mørkbak et al., 2014). However, as there is currently no carbon labelling scheme for fruit and vegetables in Germany, this was necessary. To ensure that the choice was as realistic as possible, the interviews were conducted in-store and only grocery shoppers who buy apples or tomatoes were included.

Both analyzed products cause comparatively low CO2-emissions when compared to other food products, particularly those derived from animals. Thus, it is recommend to verify the results for products which are known to have higher PCF (e.g. meat). Future research could also focus on the information provided as well as the means of communication. The information about the label and recommendations for climate friendly fruit and vegetables choices were provided in text form. In survey 2, this was accompanied by a calendar providing information on the seasonality of different production methods. This type of information could potentially be given in the form of e.g. a leaflet, poster, stand-up display at the POS or as a short film. As the information was developed in a pragmatic way, it is highly probably that e g. the wording, presentation and content affected the results. For this reason, it would be interesting to test different types of information and the means of communication.

Also, the implementation of a no-label condition for the tested scale label in the DCE can be discussed. This label provides a similar scale as the EU-energy label, which is a mandatory label in the EU. Thus, studies analyzing preferences for the EU-energy label did not use a no-label option (e.g. Sammer und Wüstenhagen, 2006; Ölander and Thøgersen, 2014). The tested scale label was inspired by the French VOC label, which has been obligatory for new products since 2012 and for all products since September 2013. Thus, there was a phase of almost two years, in which both labelled and unlabeled products were available on the French market. This was the same time in which the research design of this study was set up. Since it was not communicated to respondents that the scale label is mandatory in S2, a situation like described for the French VOC label was mimicked in the DCE. Even though this setting can be justified from a practical market perspective, it raises uncertainty about how respondents interpreted the no-label condition. As a higher utility was found for the C level than for the no-label level in the no-information group the results of this study show this aspect. This indicates that in a situation with consumer uncertainty (e.g. an introduction phase with labelled and unlabeled products), carbon labels with a scale may be ambiguous for consumers.

5. Conclusions

Using a mixed method approach, this study investigated the effect of information provision on consumers' use of carbon labels in the decision process for climate friendly products and on the preferences for carbon labels in Germany. It also investigated which types of carbon labels consumers prefer and how important these carbon labels are as a criterion of product choice. The motivation for this study was to test if the provision of additional information about labels or climate friendly food behavior directly before the food choice can stimulate the use of and preferences for carbon labels. The most important contribution of this study is that it could show that by providing additional climate-relevant information in a supermarket, use of and focus on carbon labels in a choice situation can be enhanced. It can also influence the general decision to buy or not to buy a product, the preferences for the existence of a carbon label and for emission-relevant product attributes. However, it should be noted that carbon labels are generally not important in the consumers' decision-making process. But, for those cases where carbon labels are used consumers demonstrate a preference for scale labels which use a traffic light color system.

It should be highlighted that the results provide some insight into the role of information provision in enhancing the use of and general preferences for carbon labels. It is necessary to carefully choose which information is communicated about carbon emissions and climate friendly behavior and how it is communicated to the consumers. In particular, if instruments like carbon labels or other information on climate friendly behavior is to be used as shopping aids, special efforts will be necessary to ensure reliability and validity of the labels and the content of information so that consumers trust them.

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Appendix

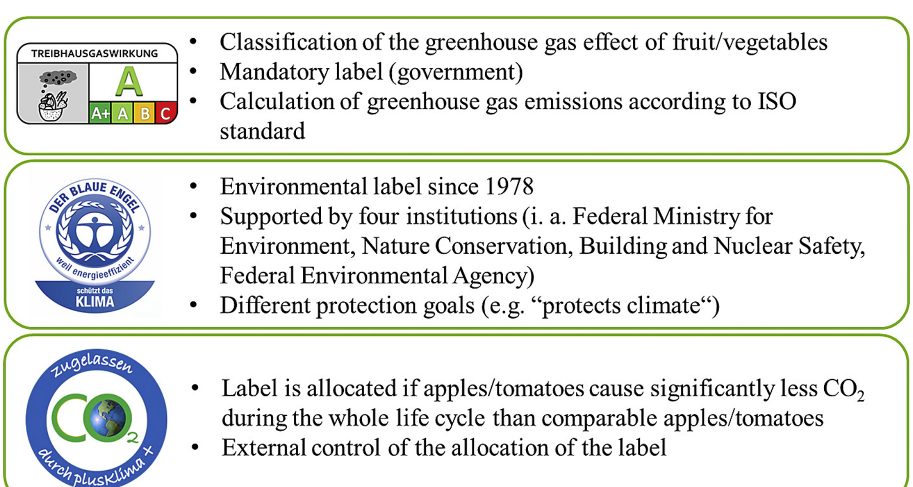


Fig. A1. Information on labels provided in survey 1 to the information group. Source of foto: http://www.blauer-engel.de/_medien/der_blaue_engel/ logos_cluster.jpg

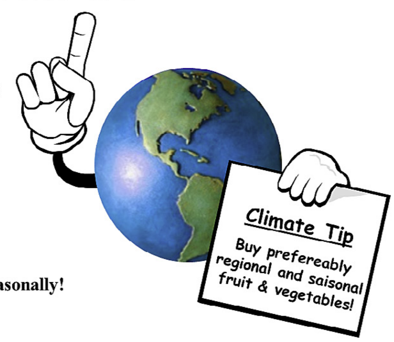
Please imagine that you want to buy fruit and vegetables and you get the following information at the point of sale:

Climate-Weeks “Fruit and Vegetables“ Did you really know?

Seasonally grown fruit and vegetables from your region are good for the climate, if they were produced similarly to fruit and vegetables grown outside the region (e.g. both on a plantation).

Regional fruit and vegetables not grown during their normal growing season:

- can have disadvantages for the climate, if unsuitable growing conditions must be compensated by technology (e.g. heating of a greenhouse).
- can be as good for the climate as imported produce, if they are produced using heat energy from renewable resources (e.g. wood chips).

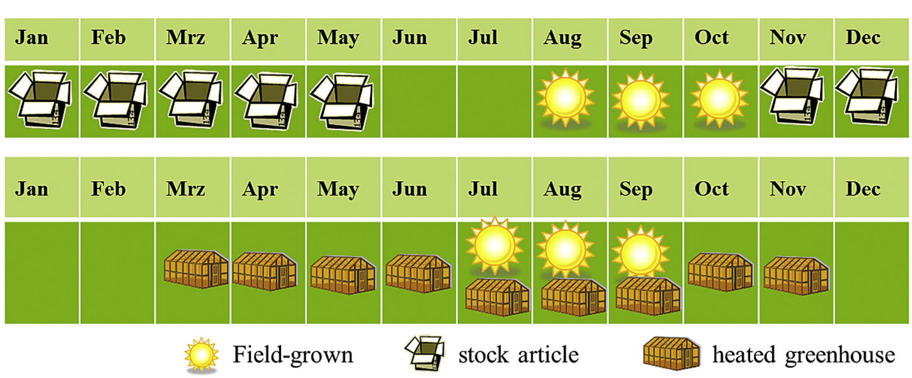


Hence, our climate tip:

Buy fruit and vegetables from your region which are grown seasonally!

(source: IFEU 2012)

Fig. A2. Information provided in survey 2 to the information group.



Source: Verbraucherzentrale NRW (2010)

Fig. A3. Information on seasonality provided in survey 2 to the information group.

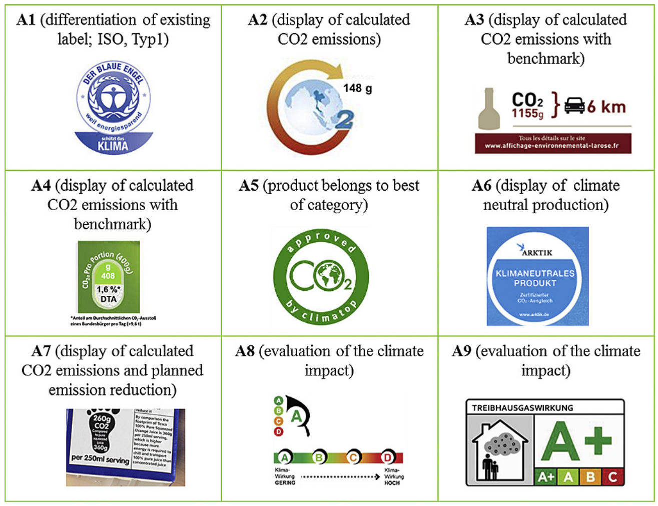


Fig. A4. The carbon labels discussed in the focus group workshop. Source of fotos (partly modified according to): http://www.blauer-engel.de/_medien/der_blaue_engel/ logos_cluster.jpg, http://thaicarbonlabel.tgo.or.th/, http://www.erasco.de/media/images/gda_zoom.jpg, Vergez (2012), http://www.climatop.ch/index.php/home_de.html, http://klimaneutral.arktik.de/carbon-footprint-und-CO2-ausgleich/produkte-pcf, http://newsimg.bbc.co.uk/media/images/44607000/jpg/_44607508_juice 226carbon trust.jpg.

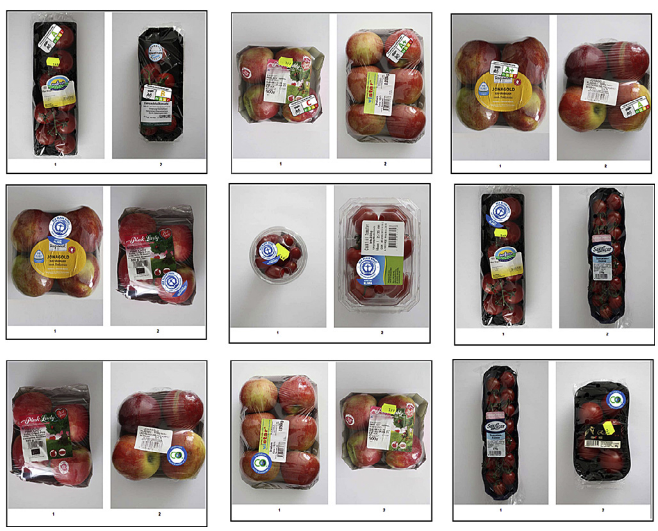


Fig. A5. The nine experimental conditions of the pairwise comparison test.

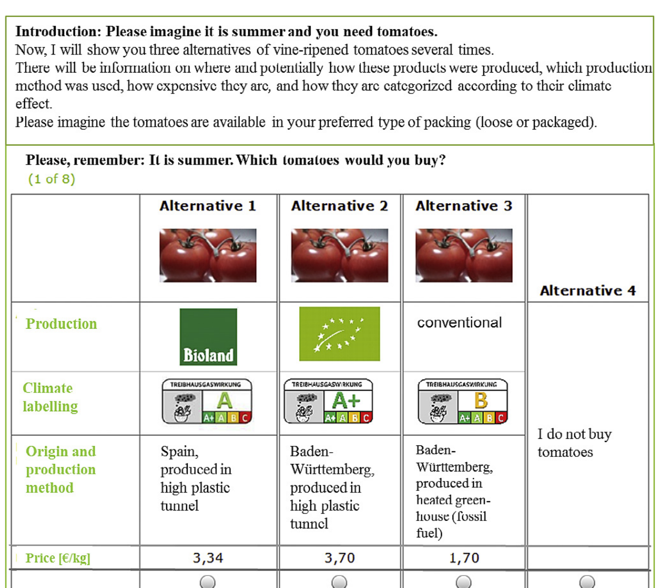


Fig. A6. Example choice set of tomato experiment. Source of foto: "https://ec.europa.eu/agriculture/organic/downloads/logo_nl, http://www.bioland.de/infos-fuer-partner/serviceleistungen/bioland-logo-und-gestaltung.html".

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